Patent Claims

1. An optical sensor for determining the concentration of dyes and/or particles in liquid or gaseous media, comprising at least one measuring head with a transmitting unit (2), provided with at least one semiconductor transmitting element (9) which emits visible light rays (8), as well as a receiving unit (3) provided with at least one semiconductor receiving element (10) onto which the portion of transmitted light rays (8) is guided which penetrates an absorption section filled with a liquid or gaseous medium, further comprising an evaluation unit (6) which is connected via electrical supply lines (4, 4') to the measuring head and is used for evaluating the receiving signals presents at the output of the semiconductor receiving element (10) for determining the dye concentration and/or the particle concentration.

2. The optical sensor according to claim 1, characterized in that it comprises several measuring heads which are connected to a joint evaluation unit (6).

3. The optical sensor according to one of the claims 1 or 2, characterized in that the measuring head, or each measuring head, is embodied as immersion sensor module having a transmitting unit (2) and a receiving unit (3) which are encapsulated so as to be impermeable to liquid.

4. The optical sensor according to claim 3, characterized in that the transmitting unit (2) and the receiving unit (3) are encapsulated with light-permeable materials, at least in the region of the optically active surfaces for the semiconductor transmitting element (9) and the semiconductor receiving element (10).

5. The optical sensor according to claim 4, characterized in that the light-permeable materials are epoxy resins or polymethacrylates, glass, Teflon, or polyolefins.

6. The optical sensor according to one of the claims 3 - 5, characterized in that the transmitting unit (2) and the receiving unit (3) are attached to a joint holder (13) for defining the absorption section.

7. The optical sensor according to claim 6, characterized in that the transmitting unit (2) and the receiving unit (3) can be secured adjustably in different positions on the holder (13).

8. The optical sensor according to one of the claims 1 or 2, characterized in that a cell filled with a liquid or gaseous medium is provided to form the absorption section, wherein the transmitting unit (2) and the receiving unit (3) are arranged on the external surfaces of this cell.

9. The optical sensor according to claim 8, characterized in that the cell is a flow-through cell.

10. The optical sensor according to one of the claims 1 - 9, characterized in that the semiconductor transmitting element (9) is a light-emitting diode or a laser diode.

11. The optical sensor according to claim 10, characterized in that the semiconductor transmitting element (9) emits transmitting light rays (8) in the wavelength range of 400nm to 700nm.

12. The optical sensor according to claim 11, characterized in that the spectral bandwidth for the semiconductor transmitting element (9) is less than 100nm.

13. The optical sensor according to one of the claims 11 or 12, characterized in that the semiconductor transmitting element (9) emits light rays (8) at the wavelength range of 470nm.

14. The optical sensor according to one of the claims 10 - 13, characterized in that a monochromatic illuminator, a filter, a gap-type aperture, or a transmitting optic are installed downstream of the semiconductor transmitting element (9), in the beam path for the transmitted light rays (8).

15. The optical sensor according to one of the claims 10 - 14, characterized in that the semiconductor transmitting element (9) is supplied with a constant direct voltage.

16. The optical sensor according to one of the claims 1 - 5, characterized in that the semiconductor receiving element (10) is a phototransistor, a photodiode, or a photo-resistor.

17. The optical sensor according to claim 16, characterized in that the semiconductor receiving element (10) is supplied with a constant direct voltage.

18. The optical sensor according to claim 17, characterized in that respectively one voltage stabilizer (15, 16) and one protective resistor (17, 18) are provided for stabilizing the direct voltage supplied to the semiconductor transmitting element (9) and the semiconductor receiving element (10).

19. The optical sensor according to one of the claims 17 or 18, characterized in that a thermistor component is additionally connected to the semiconductor transmitting element (9) for the temperature compensation of the transmitting signals and/or to the semiconductor receiving element (10) for the temperature compensation of the receiving signals.

20. The optical sensor according to one of the claims 17 - 19, characterized in that a software module is provided in the evaluation unit (6) for the temperature compensation of the receiving signals.

21. The optical sensor according to one of the claims 1 - 20, characterized in that the evaluation unit (6) is provided with an analog or digital display unit for displaying the receiving signals.

22. The optical sensor according to one of the claims 1 - 21, characterized in that the evaluation unit (6) is provided with a computer unit (20) for reading in the receiving signals via an analog/digital converter (19).

23. A method for operating an optical sensor according to one of the claims 1 - 22, characterized by the following methods steps:
realizing reference measurements with known dye concentrations or particle concentrations during a calibration operation, using reference media arranged in the absorption section, for determining a sensor-specific and dye-specific and/or particle-specific reference extinction value E_{cal};
subsequently determining extinction values E_{meas} that form actual measuring variables for liquid or gaseous media arranged in the absorption section;

and, following this, determining the dye concentration or particle concentration in the respective liquid or gaseous medium by relating the measured extinction value E_{meas} to the reference extinction value E_{cal}.

24. The method according to claim 23, characterized in that the reference extinction value is formed according to the equation $E_{cal} = \lg (I_o / I_{cal})$, wherein I_o and I_{cal} represent the signals received at the semiconductor receiving element (10) for a dye-free and/or particle-free reference medium arranged in the absorption section and a reference medium with a predetermined dye concentration and/or particle concentration C_{cal} of the dye and/or particles to be determined.

25. The method according to claim 24, characterized in that the extinction value E_{meas} which forms the actual measuring variable is formed on the basis of the equation $E_{meas} = \lg (I_o/I_{meas})$, wherein I_{meas} is the signal received at the semiconductor receiving element (10) with the liquid or gaseous medium arranged in the absorption section for the dye concentration C_x of the dye and/or the particles to be determined.

26. The method according to claim 25, characterized in that the equation $C_x = (E_{meas}/E_{cal})\ C_{cal}$ is used to determine the dye concentration and/or the particle concentration C_x.

27. The use of the optical sensor according to one of the claims 1 - 22 for determining the soot content and/or the metal abrasion content in engine oils.

28. The use of the optical sensor according to one of the claims 1 - 22 for determining pollutants in exhaust gases of motor vehicles.

29. The use of the optical sensor according to one of the claims 1 - 22 for determining the particle concentrations in exhaust air.

30. The use of the optical sensor according to one of the claims 1 - 22 for determining pollutants in waste water.